Item	Date	Content	Writer
	11/1/76	Summary Report on Analysis of Mercury in Sediments and Waters of Hackensack Meadowlands.	McCormick.
	9/10/76	Request for DEP - EPA mtg.	Longstreet
	9/28/76	Establishment of Meeting Date	Liberizzi
	10/28/76	Meeting Attendance List.	—
	11/3/76	Results of Mercury Sampling - Velsicol Site	Longstreet
	11/8/76	Request for chronologies	Hurek L.
	11/16/76	Herim Report - Biological Sampling	Duckangelo.
	11/23/76	Statement of Agreement in study direction	Simon.
	12/6/76	Organism Inventory - Hackensack Meadowlands.	Camp
	12/8/76	Chronological listing to State	Dowling.

Prepared by Mike Polito

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SUMMARY REPORT ON ANALYSES FOR MERCURY IN SEDIMENTS AND WATERS OF THE HACKENSACK MEADOWLANDS DISTRICT

Prepared for:

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East Rutherford,
New Jersey 07073

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EXECUTIVE SUMMARY [1]

Based on results of tests on sediments, the streams and wetlands throughout the central section of the Hackensack Meadowlands District of metropolitan northeastern New Jersey appear to be severely contaminated with mercury. To date, however, no animal that is likely to be used as food by human beings has been found to contain mercury at levels considered to be dangerous, and no case of human illness attributable to this contamination is known. The mercury seems to be present in a reliatvely inert form, and does not appear to pose an immediate or serious threat to wildlife or to human beings.

Sediments in the West Riser Ditch have been reported by US-EPA to contain concentrations of mercury (total) as high as 8,475 ppm (parts per million). The highest concentration reported elsewhere in the United States was 41% as great.

From May 1974 to September 1976, the mean concentration of mercury (total) in the waters of Berrys Creek at Route 3 was 9.9 ppb (parts per billion). This exceeds the highest average concentration previously reported in the literature. Monthly measurements from January through September indicated that the mean concentration of mercury in Berrys Creek during the first three quarters of 1976 was 3.9 ppb. The New Jersey stream water quality standard (5 ppb mercury) was exceeded only during January in 1976.

The highest concentration of mercury previously reported from untreated plant tissue is 3.5 ppm. Analyses by US-EPA during September 1976 suggested that rhizomes of cattail and common reed grass in a marsh along Berrys Creek contained 51 and 170 ppm mercury, respectively.

Few measurements of mercury in animals from the Meadowlands District are available. Analyses of four muskrats, one crab, and one small fish indicated that the animals contained more than normal amounts of mercury, but that the concentrations were less than the maximum considered safe for human consumption.

Aquatic plants and animals at eight stations in Berrys Creek, the Hackensack River, and adjacent tidal marshes were sampled during October 1976. The purpose of this sampling was to evaluate the distribution and relative abundance of different speices and to collect samples of organisms which represent different links in the local food chain (green plants, grazing animals, predators, and scavengers). Approximately 250 specimens are being sorted, identified, labeled, and preserved in the JMA laboratory.

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[1] Throughout this report, most concentrations of mercury are reported in ppm (parts per million). Concentrations in water, however, are reported in ppb (parts per billion). A part per billion is one <u>one-thousandth</u> (0.001) of a part per million.

We recommend that the mercury content of these plant and animal specimens be determined. The results of these analyses will verify whether or not the mercury contained in the sediments and waters of the region is entering the food chain at a rate that may pose a threat to human beings or wildlife. Our laboratories will proceed with these analyses as soon as the work is approved by the Authority.

Tests of long cores of sediments from the Berrys Creek tidal marsh indicate that the bulk of the mercury is present within about 12 to 16 inches from the surface. High concentrations of mercury, however, extend to a depth of at least 6.5 feet. The removal of only a few inches of sediment by scraping, therefore, would not eliminate all, or even most, of the contaminated material.

1. MEASUREMENTS OF MERCURY IN WATERS AND SEDIMENTS

Concentrations of mercury have been measured in many bodies of water and in their bottom sediments at various places in the world. The information derived from previous studies is summarized here to provide a basis for the interpretation of the results of recent observations made in the Hackensack Meadowlands District of New Jersey.

Comprehensive reviews of the world literature by the United States Geological Survey (1970), the Working Party on Mercury (1972), Friberg and Vostal (1972), Hartung and Dinman (1972), and D'Itri (1973) are summarized and integrated to form the bulk of this section. In addition. the findings of a comprehensive survey of estuaries in the southeastern United States, conducted by Windom (1976), also are included.

1.1 Forms of Mercury

Mercury is a heavy metal. In its uncombined form, it is a silvery liquid at normal temperatures and is nearly insoluble, but rather easily volatilized. It combines to form various inorganic compounds, such as mercuric oxide, mercuric sulphate, and mercuric chloride, and various organic compounds. Organic methylmercury generally is considered to be the environmentally most-damaging form. The oxidized, inorganic forms are relatively inert. They pose no immediate threat to living organisms, but they may be reduced to the methylated form by microorganisms.

Measurements of mercury by atomic absorption spectrophotometry or neutron activation, which are the most widely used techniques, do not distinguish between the forms of mercury present. The results are reported in terms of <u>total mercury</u>. Although any elevated concentration of mercury (total) in the environment is cause for concern, it is not possible to assess the potential ecological consequences of the mercury until the predominant form is identified or until the movement of mercury in the food chain has been determined.

1.2 General Relation Between Water and Sediments

In most forms, the solubility of mercury is low. The concentrations of dissolved mercury in freshwaters, therefore, seldom exceed 1.0 ppb (part per billion). For this reason, measurements of mercury in the water column usually are not of great importance as an indication of mercury contamination.

Mercury that is in solution commonly is adsorbed rapidly on suspended organic or inorganic particulate matter. The residence time of dissolved mercury in natural waters, therefore, is short. High concentrations of mercury that occasionally are reported from the water column probably result from mercury on suspended matter. Ultimately, the particulate matter, with the adsorbed mercury, precipitates and becomes part of the bottom sediment.

Dissolved species of mercury also may combine with soluble organic complexing agents, such as humates and fulvates, to form soluble or insoluble complexes. The insoluble complexes thus formed precipitate directly into the sediments.

Although there are several processes by which mercury is remobilized and can escape from sediments, they proceed slowly. The residence time in sediments, therefore, is long, and the bulk of the mercury present in an aquatic system is contained in the sedimentary bottom deposits.

1.3 Mercury in Uncontaminated Waters

.05 ppb

The natural concentrations of mercury in most of the rivers and lakes of the world range from 0.01 ppb to 0.1 ppb ($\leq$ 0.1 ng/g). Monitoring of the lower segments of nine major coastal rivers in Florida, Georgia, and South Carolina indicated that the mean concentrations of mercury in the water columns ranged from 0.04 to 0.07 ppb. The maximum concentrations observed varied between 0.06 and 0.14 ppb.

The reported concentrations of mercury in oceanic waters vary from 0.003 ppb to about 0.3 ppb. In littoral waters off the Atlantic Coast, between South Carolina and northern Florida, the mean annual concentration of mercury is 0.060 ppb. The minimum concentration observed was 0.005 ppb, but during periods of offshore winds the level of mercury increases to as much as 0.3 ppb.

1.4 Mercury in Contaminated Waters

Waters which drain from areas of high natural mercury content or from industrialized areas usually contain mercury in concentrations greater than 0.1 ppb.

Streams in contaminated areas of Sweden were found to contain maximum levels of 0.36 to 0.56 ppb mercury, but one reading of 34 ppb was reported. Tests in the North American Great Lakes, which are subject to industrial discharges, indicated that the concentration of mercury in Lake Superior is 0.12 ppb and that in Lake Ontario is 0.39 ppb. Concentrations of the metal in streams which drain areas rich in mercury ores range from 1 to 3 ppb, but levels as high as 3.6 ppb and (one report) 136 ppb have been observed.

1.5 Mercury in Uncontaminated Sediments

.05 ppm

In rivers, lakes, oceans, and marshes in areas which are not exposed to industrial contamination or major contributions of mercury from ore bodies, sandy sediments generally contain mercury in concentrations of less than 0.05 ppm and organic or clayey sediments generally contain mercury in concentrations less than 0.15 ppm. The average concentration of mercury in cores of sediment from twenty-five stations in saline tidal marshes along the Atlantic Coast from northern Florida to South Carolina was 0.07 ppm.

1.6 Mercury in Contaminated Sediments

Sediments exposed to contributions of mercury from natural deposits or from industrial sources may exhibit concentrations that are substantially higher than the natural background levels. Although no absolute concentration can be said universally to represent the division between uncontaminated and contaminated materials, levels in excess of 0.2 ppm are suspect and those that exceed 1.0 ppm almost certainly are contaminated.

In the literature consulted for this review, the highest concentration of mercury reported in sediments from locations other than Berrys Creek was 3,504 ppm. This level was observed in a swamp adjacent to a chemical plant at Ashland, Massachusetts. The conentrations in sediments in a small brook downstream from the plant ranged to 1,000 ppm. The highest concentration reported from other localities in New Jersey was 254 ppm. This level was observed in sludge discharged from a chemical plant to a small tributary of the Arthur Kill.

2. MEASUREMENTS OF MERCURY IN LIVING ORGANISMS

2.1 Mercury in Birds and Mammals

The maximum natural background level of mercury (total) in biological materials, including birds and mammals, is about 0.035 ppm (wet weight). Concentrations of more than 0.035 ppm mercury in tissue samples may reflect enrichment from natural sources of mercury or contamination from manmade sources. Concentrations of mercury (total) as great as 10 to 175 ppm have been found in the livers of mammals and birds from contaminated areas.

2.2 Mercury in Fish

The background level of mercury (total) in fillets of fish (muscle tissue, excluding bone) from uncontamined waters is considered to be 0.20 ppm (wet weight) or less. The United States Food and Drug Administration permits the sale of fish that contain no more than 0.5 ppm mercury, and analyses of historic and recent collections of fish from deep ocean waters indicate that concentrations in the range from 0.30 to 0.76 ppm occur naturally. Grossly contaminated specimens have been observed to contain concentrations of mercury (total) as great as 9.8 ppm in muscle tissue.

In a particular body of water, the larger individuals of any particular species of fish usually contain higher concentrations of mercury than do smaller individuals. There also is a magnification of mercury along the food chain, so that predators contain mercury in higher concentrations than do herbivores. For example, at all localities examined in Sweden, the predatory pike exhibited the highest concentrations of mercury. The overall concentration factor from water to pike is approximately 3,000. Thus, if the water contains 0.17 ppb mercury, predatory fish may exhibit a residue level of 0.5 ppm (500 ppb).

2.3 Mercury in the Benthos

Based on collections of crustaceans (*Mysis*, *Pontoporeia*) from the bottom of Lake Michigan, which is considered to be "relatively free" of mercury pollution, the average concentration of mercury in the benthos during 1970 was 1.4 ppm (range 0.42 to 4.2 ppm, dry weight). This is equivalent to approximately 0.3 ppm on a wet-weight basis.

2.4 Mercury in Plankton

The average concentration of mercury in phytoplankton collected during 1970 from Lake Michigan was 2.2 ppm (range 0.89 to 4.5 ppm, dry weight). In zooplankton, the average concentration of mercury was 0.9 ppm (0.23 to 2.7 ppm, dry weight). These averages equate approximately to 0.44 and 0.2 ppm on a wet-weight basis.

2.5 Mercury in Rooted Plants

The natural background level of mercury in plant tissues seldom exceeds 0.5 ppm. In habitats that contain mercury-bearing deposits, dried plant tissues may contain from 0.5 to 3.5 ppm mercury. Higher concentrations of mercury may occur in the tissues of plants intentionally treated with mercury compounds or exposed to contamination.

3. HISTORY OF CONTAMINATION OF BERRYS CREEK

About 1 mile upstream from Paterson Plank Road, two channels join to form Berrys Creek. These channels are known as the East and West Riser Ditches. The former natural channels of the stream apparently were modified to expedite drainage in the watershed and tide gates were installed to prevent high waters from extending upstream.

A chemical processing plant was constructed on the west bank of the West Riser Ditch in Wood-Ridge during the period from 1915 to 1920. At least as early as 1936, when new owners acquired the plant, the facility began to employ mercury in processing. From about 1937 to the end of 1973, the facility engaged principally in the processing of mercury. 73 37 36

The State and Federal regulatory agencies allegedly required regular reports on the quality of effluent discharged from the chemical plant during the early 1970's. The fact that mercury has accumulated in the marsh and channel sediments of the region, however, was not generally known until 1972.

Routine tests conducted on 5 June 1972 as part of an environmental assessment of plans for the New Jersey Sports Complex revealed exceptionally high concentrations of mercury in sediments of the Berrys Creek tidal marsh ("Walden Swamp") and adjacent channels. The results of these tests were published in an environmental assessment document distributed by the New Jersey Sports and Exposition Authority (Jack McCormick & Associates 1972). Additional tests were made on 15 and 16 June 1972 and the results were aired during a public hearing held by the New Jersey Department of Environmental Protection and the Hackensack Meadowlands Development Commission in July 1972.

During October 1972, the United States Environmental Protection Agency issued a report on the control of mercury contamination in sediments (Feick and others 1972). In a review of data on known sites of mercury pollution, the concentrations of mercury in Berrys Creek at the Wood-Ridge site were described as, "In sediments, 8475 ppm at Ventron outfall, 7440 ppm 100 yards downstream." These concentrations were approximately 40 times greater than those detected during 1972 in analyses of sediments from the Berrys Creek tidal marsh adjacent to the Sports Complex.

Additional tests of sediments from the Berrys Creek tidal marsh were conducted for the Sports Authority during 1974. This testing was coordinated closely with the Hackensack Meadowlands Development Commission and the New Jersey Department of Environmental Protection. The results of the tests, which confirmed the data obtained from the site during 1972, were included in a "Supplementary Report [on] Mercury Concentrations in Berrys Creek Marsh," dated 16 April 1974 and appended to the New Jersey Sports Complex Monitoring Report 14 for the Month of March 1974. All of the data were included in a Federal environmental impact statement published by the New York District (1975).

3.1 Results of 1972 and 1974 Tests on Berrys Creek Marsh

Samples of sediments first were collected from the Berrys Creek tidal marsh on 5 June 1972 for routine evaluations associated with an assessment of the potential environmental impact of the construction of the New Jersey Sports Complex. The results of the analyses of the samples suggested that the concentrations of mercury in the sediments were unusually high. Additional samples were collected on 15 and 16 June 1972 to verify or correct the original determinations. Owing to questions about the reliability of the entire series of 1972 tests, another set of samples was collected on 21 February 1974. The results of all of these tests, which are displayed in Table 1, were consistent. Sample station locations are mapped on Figure 1.

The following conclusions were drawn from the 1972 and 1974 test results:

1. The degree of contamination varies from place to place throughout the marsh, but all stations are significantly polluted with mercury.

2. The degree of contamination of the tidal marsh varies with depth in the sediment. The heaviest contamination is in the upper 0-6 inches (36.7 to 75 ppm), but significant contamination extends at least to a depth of 30 to 36 inches (5.5 to 14.6 ppm).

3. Within the upper 6 inches of the marsh sediments, contamination was less from 0-2 inches (2.3 to 26 ppm) than from 4-6 inches (7.0 to 208 ppm) at five of six stations.

4. Mercury concentrations in the meadow mat, or dead plant remains and live rootstocks, were higher (28.4 to 37.8 ppm) than concentrations in the upper 2 inches of marsh sediment (2.3 to 26 ppm). This suggests that the marsh plants absorb mercury and incorporate the metal into their tissues. The presence of significant mercury concentrations at depths from 30-36 inches below the soil surface also could reflect downward translocation of mercury by plant rhizomes and roots.

5. Distribution of mercury in the stream channel sediments was dissimilar to that in the marsh. A high concentration was detected in the upper 0-2 inches, an intermediately high concentration from 2-4 inches, and an "uncontaminated" condition from 4-6 inches. These data suggest that (a) contaminated sediments may be mobile in the channel — that is, they may be moving as a bottom load from the marsh drainage into Berrys Creek and thence to the Hackensack River; (b) the sediments removed are replaced continuously by sediments eroded from the marsh surface; and (c) there is no downward movement of mercury into the deeper channel bottom sediments because no rooted plants are present. The lack of downward movement also may reflect the fact that the channel bottom is at or slightly below the mean low water line. Under this condition, there probably is no net vertical movement of water through the sediment.

Table 1. Results of analyses for mercury in sediments collected during 1972 and 1974 from the Berrys Creek tidal marsh, Borough of East Rutherford, Bergen County, New Jersey. All concentrations are expressed in parts per million of oven-dry sediment (mg/kg). Stations are located on Figure 1.

Station	Organic Mat	Sediments (Inches)				
		0-2	2-4	4-6	0-6	30-36
1		19		7.4		
2[a]		74	38	0.30		
3		26		44		
4	29.2				61.7	8.3
5		3.0		208		
6	28.4				60.1	7.1
7	37.8				40.6	9.1
8		2.3		8.2		
9	29.9				36.7	14.6
10		6.0		7.0		
11		6.7		96.2		
12	33.9				75	5.5

[a] The sample from Station 2 represents channel bottom sediments from a tidal gut; other stations were in marsh areas.

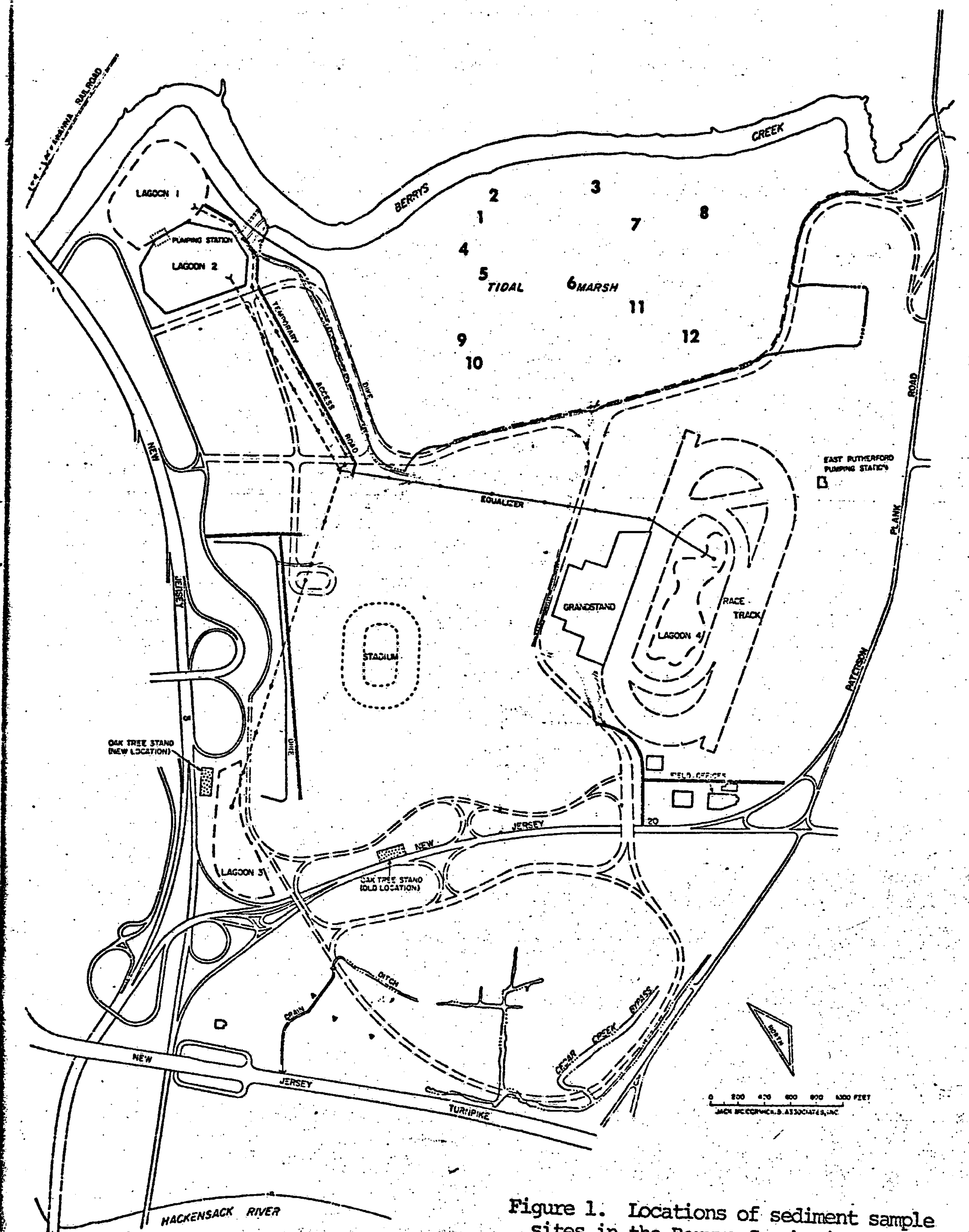

Figure 1. Locations of sediment sample sites in the Berrys Creek Tidal Marsh, 1972 and 1974.

4. GEOGRAPHIC VARIATIONS IN MERCURY CONCENTRATIONS IN MARSH SEDIMENTS IN THE MEADOWLANDS

Investigations for the New Jersey Sports and Exposition Authority during 1972 and 1974 revealed the presence of mercury in sediments of the Berrys Creek tidal marsh between Route 3 and Paterson Plank Road in East Rutherford, Bergen County, New Jersey. Historical data suggested that the source of the mercury was a former chemical plant upstream from Paterson Plank Road. No information was available, however, to indicate the extent of contaminated sediments in the region or to evaluate the relative degree of contamination from place to place.

To provide information on the geographical characteristics of mercury contamination, cores of surface sediments were collected during March 1976 from ten stations in tidal marshes along or near Berrys Creek, the Berrys Creek Canal, and the Hackensack River. The locations of these stations are indicated on Figure 2. The letters BCTM identify the location of the Berrys Creek tidal marsh.

At each of the ten stations, four sediment cores ("short cores") were extracted. Each core was 4 inches long. The materials from 0 to 2 inches and the materials from 2 to 4 inches in depth in each core were separated, and the materials from equivalent depths in the four cores then were mixed together. The concentration of mercury in each of the two composite samples (0 to 2 inches; 2 to 4 inches) then was determined.

The results of the analyses are listed in Table 2. The concentrations of mercury ranged from 3.2 ppm in the 2 to 4 inch sample at Station 10 (Sawmill Creek) to 262 ppm in the 2 to 4 inch sample at Station 2 (upstream from Paterson Plank Road).

At some stations, the concentration of mercury was highest in the 0 to 2 inch sample, at other stations the concentration was greatest in the 2 to 4 inch sample. These discrepancies probably reflect frequent erosion and redeposition of the surficial sediments, as well as place to place variations related to stream velocity and other factors. To present a more uniform picture, therefore, we listed the highest concentration measured at each station, regardless of depth. These are shown in parentheses on Figure 1 and are expressed as mg/kg (ppm). The concentration shown for the Berrys Creek tidal marsh represents the highest value measured in the long cores collected from that area.

Marsh sediments associated with the section of Berrys Creek upstream from the Route 3 bridge contain substantially higher concentrations of mercury (240 to 262 ppm) than do sediments in other areas examined (3.6 to 61 ppm; Figure 2). The Berrys Creek tidal marsh, adjacent to the Sports Complex, is in this section. Sediments from Station 3, which also is in this segment, contained a lower concentration of mercury (47 ppm) than did samples from nearby stations. This anomaly may reflect the fact that Station 3 was protected by a dike or that some fill material has been placed on the area at some time in the recent past.

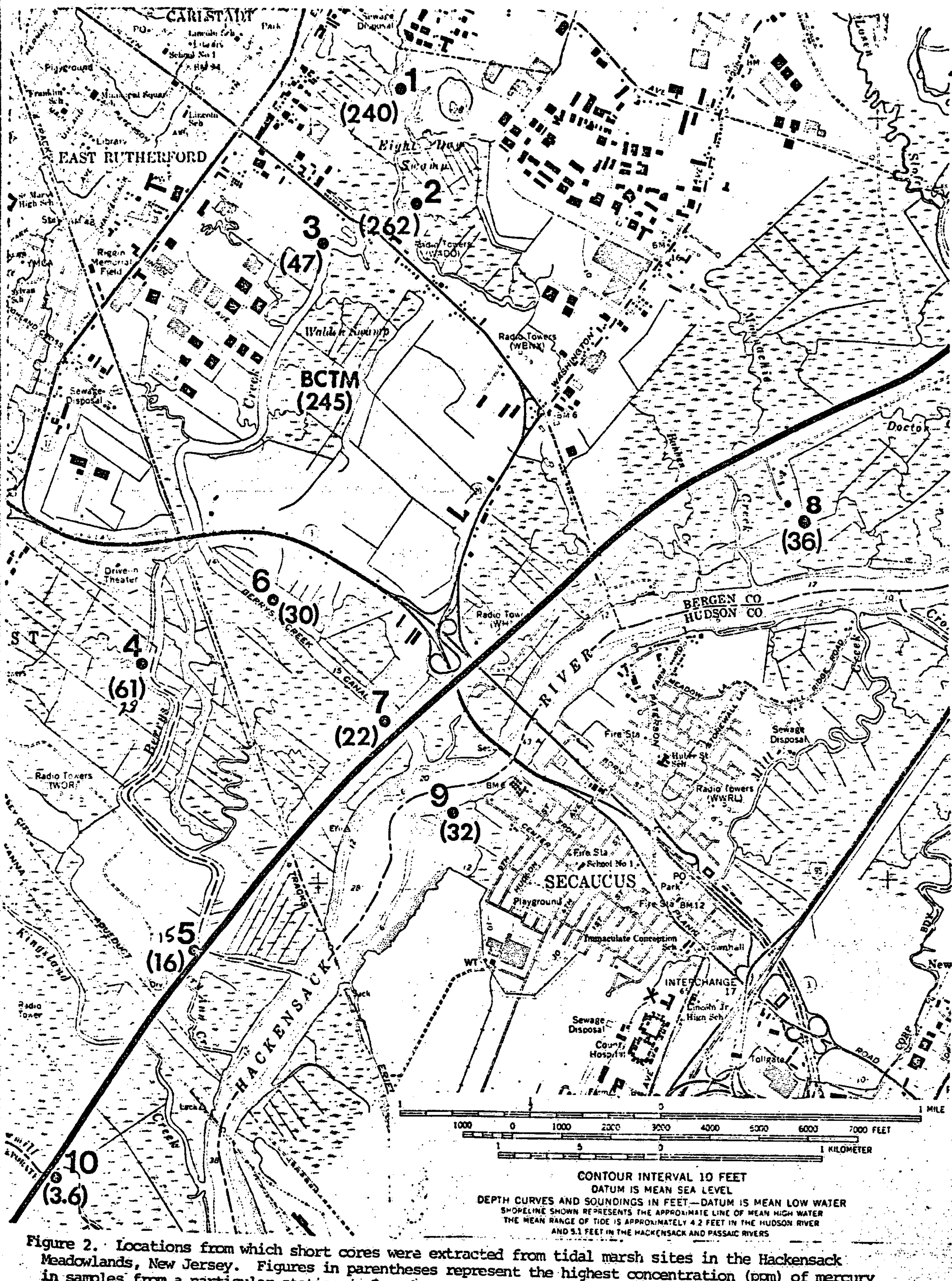

Figure 2. Locations from which short cores were extracted from tidal marsh sites in the Hackensack Meadowlands, New Jersey. Figures in parentheses represent the highest concentration (ppm) of mercury in samples from a particular station. Complete analytical results are listed in Table 2.

Table 2. Concentration of mercury in short cores in the vicinity of the site of the New Jersey Sports and Exposition Complex, 18 and 19 March 1976. Values are expressed in mg/kg dry weight (ppm). Locations of sampling stations are shown on Figure 2.

SAMPLE	CONCENTRATION OF MERCURY 0-2 in.	2-4 in.
1	240	180
2	82	262
3	44	47
4	61	27
5	16	15
6	15	30
7	5.3	22
8	36	30
9	32	3.9
10	3.2	3.6

5. VERTICAL DISTRIBUTION OF MERCURY IN MARSH SEDIMENTS

The results of the preliminary analyses of sediments during 1972 suggested that mercury is present in the highest concentrations in the uppermost 6 inches of sediment in the Berrys Creek tidal marsh. Tests on longer cores collected during 1974, however, suggested that sediments as deep as 3 feet beneath the surface may contain very substantial concentrations of mercury.

The feasibility of certain methods for the decontamination or removal of marsh sediments may be limited by the depth to which very high concentrations of the metal extend. To define the vertical distribution more precisely, longer cores were extracted during 1976, and more intensive analyses of the sediments were made. These long cores were obtained from five stations in the Berrys Creek tidal marsh (Figure 3) and from two stations in the Sawmill Creek Wildlife Management Area (Figure 5).

The cores were c llected in plastic tubes and returned to the laboratory for processing. The length (depth) of the cores varied, depending upon the nearness to the surface of an impenetrable clay layer. In the laboratory, the cores were sectioned longitudinally and a log of sediment layers was made.

Generally, the cores were composed of alternating layers of brown to reddish-brown peat, black peat and organic clay, and a white or gray to yellowish-brown clay. A composite sample of each identifiable layer, or of segments within a thick layer, was collected by scraping the surface of the central part of the section face. From seven to ten composite samples from each core were anlayzed for mercury.

5.1 Long Cores from the Berrys Creek Tidal Marsh

The results of the analyses of cores from the Berrys Creek tidal marsh are shown graphically in Figure 4. The data also are summarized in Table 3 and are presented in more detail in Table 4.

At three of the five test sites in the Berrys Creek tidal marsh, a brown peat (meadow mat) formed a surficial layer that was 0.1 to 0.2 foot thick. The concentrations of mercury in this layer ranged from 21 to 136 ppm.

A black peat and organic clay was exposed at the surface at Stations 2 and 5, and it occurred beneath the peat at the other stations. The layer varied in thickness from 0.1 to 0.7 foot. The concentrations of mercury in this black layer ranged from 20 to 245 ppm.

Where the brown peat overlaid the black layer, the concentration of mercury was higher in the black layer at two stations (Station 1, 35/85 ppm; Station 4, 136/245 ppm). At Station 3, the concentrations essentially were the same (20/21 ppm).

Brown to reddish-brown peat (probably from the former Walden Swamp forest) lies under the black layer at all stations. It varies from 3.0 to 4.6 feet in thickness. Concentrations of mercury in this peat ranged from less than 1 to 16 ppm, and fifteen of the seventeen measurements were 9 ppm or less.

Beneath the peat there is a bed of gray or white to yellowish-brown clay. The top of this bed is 3.1 to 5.5 feet under the marsh surface. Measured concentrations of mercury in the clay ranged from less than 1 to 3 ppm, with one anomalous measurement of 14 ppm.

Only one boring penetrated the clay bed. At Station 1 a brown peat was sampled 6.2 to 6.5 feet below the surface. The measured concentration of mercury in the composite sample from this core was 8 ppm.

5.2 Long Cores from the Sawmill Creek Area

Two long cores were extracted from the Sawmill Creek Wildlife Management Area (Figure 5, Table 5). The concentration of mercury in the surficial black layer of the core from Station 6, in an extensive intertidal mudflat to the east of the Western Spur of the New Jersey Turnpike, was 18 ppm. Sediments in the remainder of the core contained from 0.2 to 1 ppm mercury. In the core from Station 7, the contaminations of mercury measured in the surficial layers were 5.6 to 5.9 ppm. In sediments from 0.9 to 5.8 feet beneath the surface, the concentrations ranged from 0.3 to 3.4 ppm. At intermediate depth (0.6 to 0.9 foot), however, the observed concentration was 24 ppm. To verify this seemingly anomalous reading, several replicate aliquots of the sample were tested, and the results were consistent.

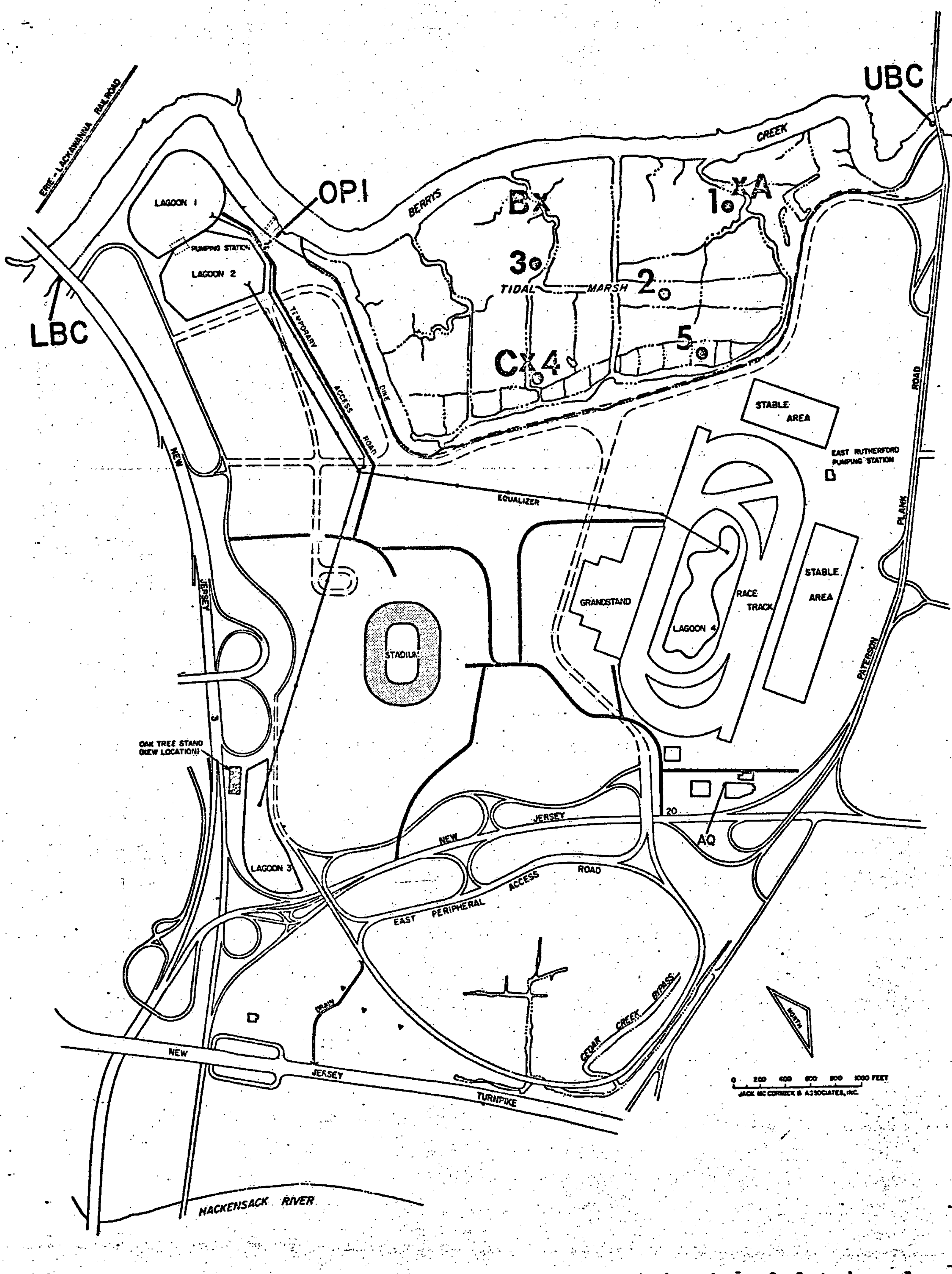

Figure 3. Locations from which long cores (numbered dots) and channel sediments (lettered exes) were extracted from the Berrys Creek tidal marsh, East Rutherford, New Jersey. Concentrations of mercury in samples from the cores are listed in Table 3.

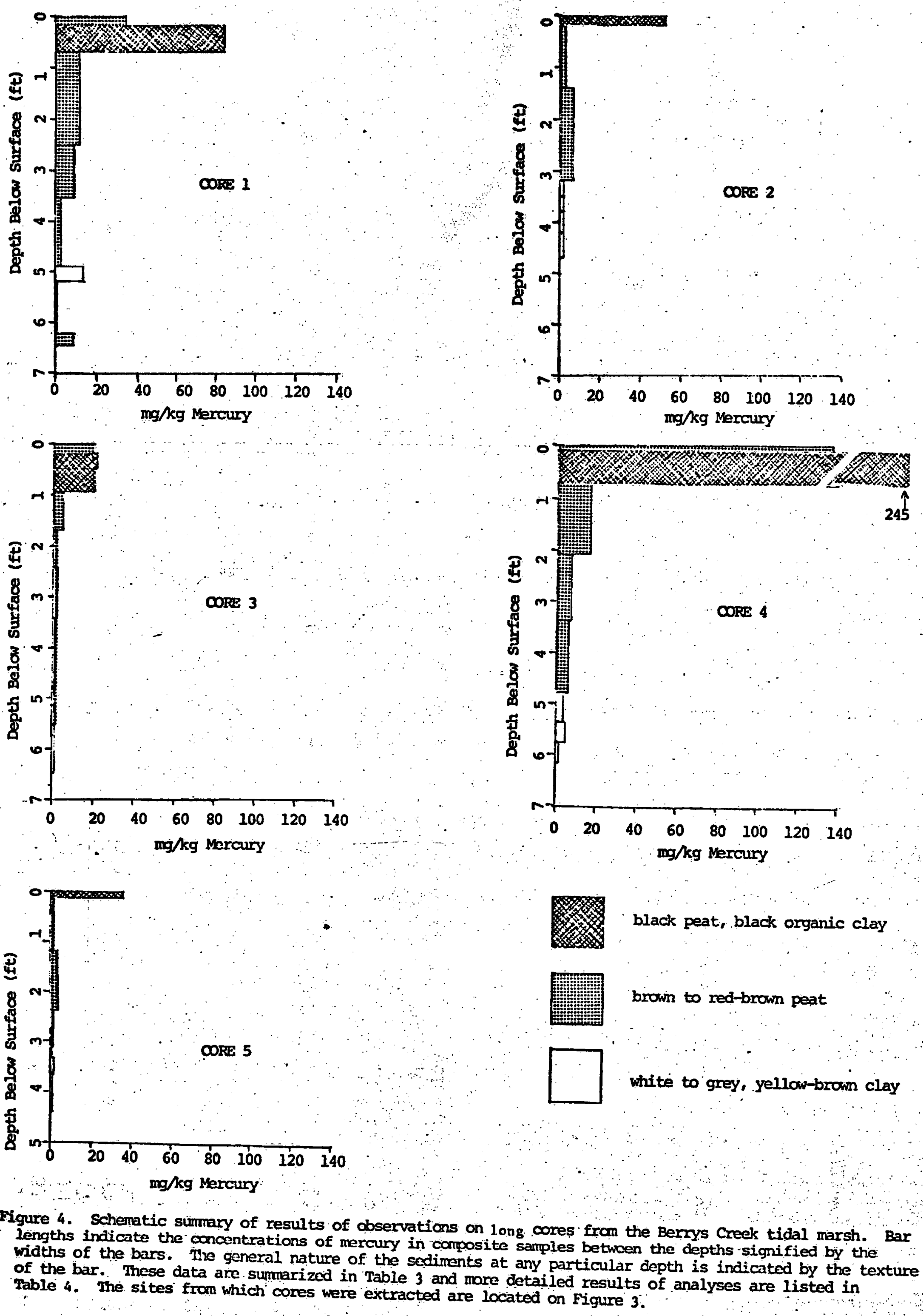

Figure 4. Schematic summary of results of observations on long cores from the Berrys Creek tidal marsh. Bar lengths indicate the concentrations of mercury in composite samples between the depths signified by the widths of the bars. The general nature of the sediments at any particular depth is indicated by the texture of the bar. These data are summarized in Table 3 and more detailed results of analyses are listed in Table 4. The sites from which cores were extracted are located on Figure 3.

Table 3. Summary of results of tests on long cores extracted from the Berrys Creek tidal marsh, East Rutherford, New Jersey, 23 and 24 March 1976. The depth to the bottom of each sample segment is measured in tenths of feet. Concentrations of mercury (conc) are expressed in milligrams of mercury per kilogram of oven-dry sediment (parts per million). The location of sites from which cores were obtained are indicated on Figure 3.

Core:	1		2		3		4		5	
	Depth	Conc	Depth	Conc	Depth	Conc	Depth	Conc	Depth	Conc
Surface	0.0	-	0.0	-	0.0	-	0.0	-	0.0	-
Brown peat	0.2	35	-	-	0.2	21	0.1	136	-	-
Black peat, clay	0.7	84	0.2	53	0.5	20	0.8	245	0.1	36
					0.9	20				
Brown peat	2.5	12	1.4	3	1.7	5	2.1	16	2.4	5
	3.5	9	3.2	7	2.4	2	3.4	7	2.7	2
	4.9	2			3.4	3	4.8	7	3.1	1
					4.8	1				
					5.2	<1				
					5.5	1				
Clay	5.2	14	3.5	<1	6.5	1	5.4	2	3.3	1
	5.4	<1	3.8	<1			5.8	3	3.6	3
	5.7	<1	4.2	<1			6.2	1	4.3	1
	6.2	<1	4.7	<1					4.4	1
Brown peat	6.5	8								

Table 4. Concentrations of mercury in composite samples from long cores extracted from the Berrys Creek tidal marsh, 23 and 24 March 1976. Concentrations are expressed in milligrams of mercury per kilogram of oven-dry sediment (parts per million). Sites from which cores were obtained are located on Figure 3.

CORE	DEPTH (FEET)	MERCURY CONCENTRATION
1	0.0 - 0.2	35
	0.2 - 0.7	84
	0.7 - 2.5	12
	2.5 - 3.5	9.2
	3.5 - 4.9	2.4
	4.9 - 5.2	14
	5.2 - 5.4	0.4
	5.4 - 5.7	0.3
	5.7 - 6.2	0.3
	6.2 - 6.5	8.4
2	0.0 - 0.2	53
	0.2 - 1.4	3
	1.4 - 3.2	7.2
	3.2 - 3.5	0.5
	3.5 - 3.8	0.4
	3.8 - 4.2	0.4
	4.2 - 4.7	0.3
3	0.0 - 0.2	21
	0.2 - 0.5	20
	0.5 - 0.9	20
	0.9 - 1.7	4.9
	1.7 - 2.4	1.6
	2.4 - 3.4	2.8
	3.4 - 4.8	1.4
	4.8 - 5.2	0.4
	5.2 - 5.5	0.7
	5.5 - 6.5	0.8
4	0.0 - 0.1	136
	0.1 - 0.8	245
	0.8 - 2.1	16
	2.1 - 3.4	7.2
	3.4 - 4.8	6.6
	4.8 - 5.4	2.4
	5.4 - 5.8	3
	5.8 - 6.2	1
5	0.0 - 0.1	36
	0.1 - 2.4	4.5
	2.4 - 2.7	1.8
	2.7 - 3.1	1.4
	3.1 - 3.3	0.9
	3.3 - 3.6	2.5
	3.6 - 4.3	1
	4.3 - 4.4	0.7

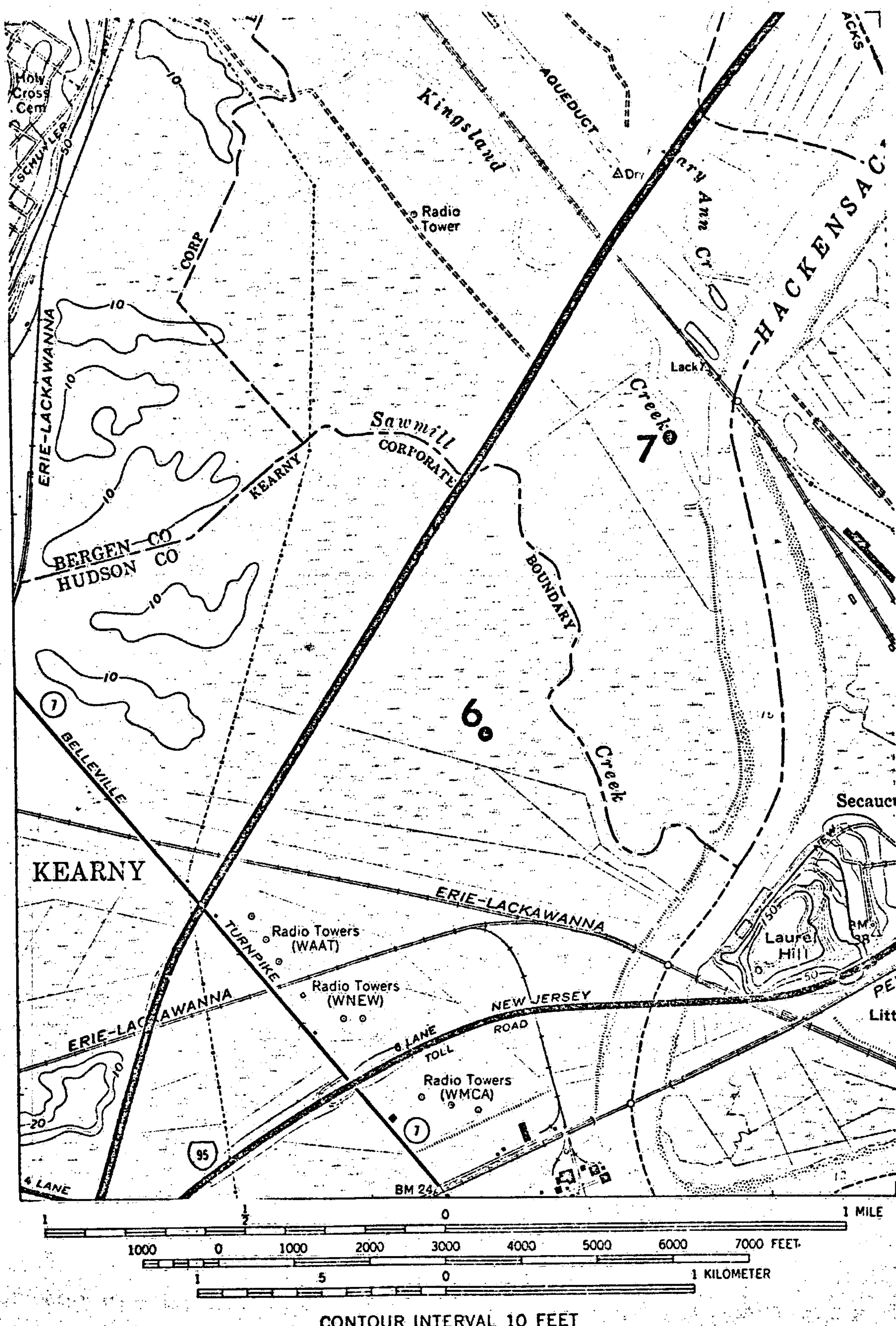

Figure 5. Locations from which long cores were extracted from the Sawmill Creek Wildlife Management Area. Concentrations of mercury in samples from the cores are listed in Table 6.

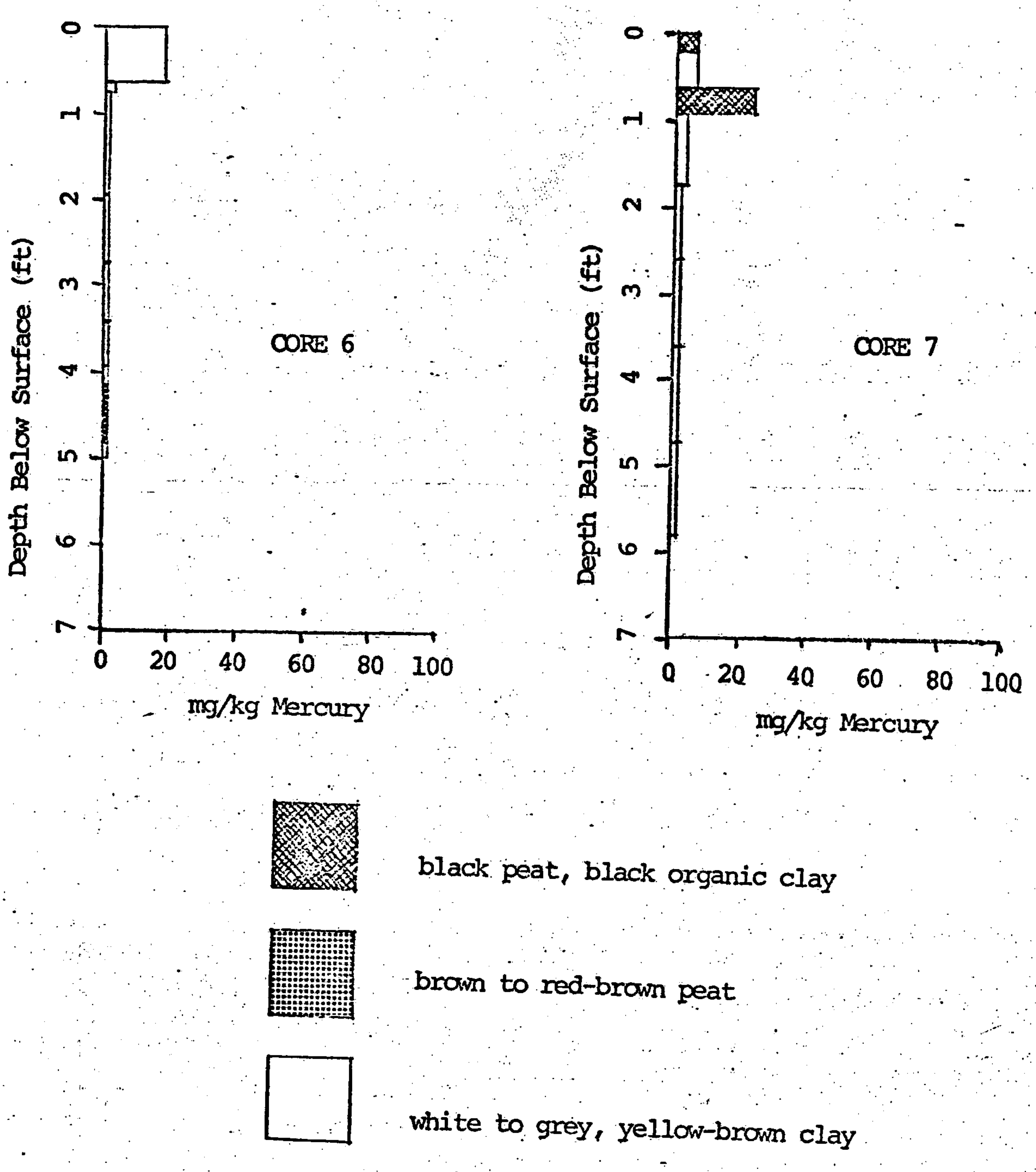

Figure 6. Schematic summary of results of observations on long cores from the Sawmill Creek Wildlife Area. The mechanics of the graphs are explained in Figure 4. These data also are presented in Table 5. The sites from which the cores were extracted are located on Figure 5.

Table 5. Concentrations of mercury in composite samples from long cores extracted from the Sawmill Creek Wildlife Refuge, 24 March 1976. Concentrations are expressed in milligrams of mercury per kilogram of oven-dry sediment (parts per million). Sites from which cores were obtained are located on Figure 5.

CORE	DEPTH (FEET)	MERCURY CONCENTRATION
6	0.0 - 0.6	18
	0.6 - 0.7	2.8
	0.7 - 1.9	0.5
	1.9 - 2.7	0.5
	2.7 - 3.4	1
	3.4 - 3.9	0.6
	3.9 - 4.2	0.4
	4.2 - 4.8	0.4
	4.8 - 5.0	0.2
7	0.0 - 0.2	5.6
	0.2 - 0.6	5.9
	0.6 - 0.9	24
	0.9 - 1.7	3.4
	1.7 - 2.2	1.2
	2.2 - 3.6	1.3
	3.6 - 4.7	1.2
	4.7 - 5.8	0.3

6. MERCURY IN CHANNEL-BOTTOM SEDIMENTS

Analyses of sediments from the channels, or guts, in Berrys Creek tidal marsh were conducted to test the hypothesis that a principal avenue of movement of mercury may be in the form of bed load transport. This hypothesis was drawn from the fact that analyses during 1972 indicated that the surficial channel-bottom sediments (0 to 5 cm) contain considerably higher concentrations of mercury than do the underlying sediments (10 to 15 cm). The magnitude of the observed difference was 73.7 ppm. This hypothesis, however, seems to contradict reports in the literature that most mercury is adsorbed on organic matter and/or silt- and clay-size mineral matter. These particles usually move in suspension rather than as a bed load.

The locations of sampling sites are indicated by letter designations on Figure 3. The sediment cores were collected in plastic tubes and returned to the laboratory for processing. The materials from 0 to 1 cm and the materials from 2 to 3 cm in depth in each core were separated. Each subsample then was seived to separate sand-size sediments from silt- and clay-size (combined) sediments. The weight of the sediment in each class was determined and the percentage of the total weight of the core represented by each class was calculated (mechanical composition). The concentration of mercury in the sand- and in the silt- and clay-size fractions of an aliquot of each subsample then was determined. From these measurements, the concentration in each total subsample was calculated. The remaining aliquot of each subsample then was ashed in a muffle furnace to determine the proportional content of organic matter. The results of these investigations are summarized in Table 6.

Each of the three cores was composed of a uniform black mud. No differences in appearance were noted between the cores or between different depths in any particular core. Under microscopic examination, the predominant components of the samples were observed to be clay and plant fibers. Grains of mica and quartz were the most abundant sand-size mineral fragments, but they formed only a small percentage of the total volume of the sediments. A few formaniniferal tests (*Trachammina* cf. *inflata*), ostracode carapaces, tintinnid tests, and diatom fragments also were observed.

The mean concentration of mercury in the sand-size fraction of the cores was 211 ppm, whereas the mean concentration in the clay-size fraction was 188 ppm. Although these results seem to conflict with earlier reports in the literature that mercury is more abundant on silt and clay particles than on sand grains, ignition tests resolved the matter. Upon incineration, the sand-size materials lost 16.1% of their total weight and the silt/clay-size materials lost 2.7% of their total weight. The total loss of weight suggests that the mean organic content of the sediments was 18.8%, of which 86% was contained in the sand-size fraction. This supported the visual observation that the sand-size fraction was formed almost entirely of small pellets composed of organic material and silt/clay-size mineral particles. Some of the pellets resembled the excretions of burrowing organisms.

In each of the three cores, the concentration of mercury (total) was greater in the lower section (2-3 cm) than in the surficial (0-1 cm). The mean concentrations in the cores were 184 ppm (surface), 227.3 ppm (depth), and 205.7 ppm (total sample). The concentrations in the subsamples ranged from 43 ppm (Station C, surface) to 455 ppm (Station B, subsurface). The maximum concentration observed in the channel-bottom sediments, thus, is nearly twice as high as the maximum concentration measured in the short cores from marshes (262 ppm, at Station 2 on Figure 2). Similarly, it is nearly twice as great as the maximum level observed in the long cores from the adjacent Berrys Creek tidal marsh surface (245 ppm, in Core 4 on Figure 3). Sediments from Station C, which is within a few feet from the site at which Core 4 was obtained, exhibited the lowest concentration of mercury measured in the channel bottom samples (43 ppm and 46 ppm, respectively, in the surface and subsurface).

Table 6. Results of mechanical analyses, ignition tests, and mercury analyses on sediments from guts in the Berrys Creek tidal marsh. Sand and clay are descriptive of size classes and do not infer composition. Organic content is the proportion of weight lost upon ignition in a muffle furnace. All data on mechanical composition are expressed as percentages of total dry weight.

	Station A		Station B		Station C	
Depth (cm)	0-1	2-3	0-1	2-3	0-1	2-3
Mechanical Composition						
Sand	73	82	82	79	82	85
Clay	27	18	18	21	18	15
Ignition Test						
Sand						
Mineral	55	66	66.2	63.7	66.5	69
Organic	18	16	15.8	15.3	15.5	16
Clay						
Mineral	22.7	16	15.1	18.4	15	13.4
Organic	4.3	2	2.9	2.6	3	1.6
Total						
Organic	22.3	18	18.7	17.9	18.5	17.6
Mineral	77.3	82	81.3	82.1	81.5	82.4
Mercury (ppm)						
In sand	88	190	440	480	38	29
In clay	99	140	320	360	67	140
Total	91	181	418	455	43	46

7. REVIEW OF WATER QUALITY MONITORING RESULTS

Since May 1974, analyses to determine the concentration of mercury in the waters of Berrys Creek have been made from time to time. The results of these analyses are listed in Table 7.

The highest observed concentration of mercury during the period from May 1974 through September 1976 was 136 ppb (parts per billion) on 17 May 1974. This was more than 27 times as great as the maximum prescribed by the New Jersey surface water standards (5 ppb). At the time of the observation, the former chemical processing plant at Wood-Ridge was being demolished. It is assumed, therefore, that the mercury originated at that site.

Concentrations of mercury that exceeded the State standard also were measured on several other dates during July, September, October, and November in 1974, and during December 1975 and January 1976. No subsequent analysis during 1976 exceeded the standard.

These results may indicate two aspects of the mercury condition. First, there apparently has been a reduction in the release of mercury from the Wood-Ridge site. Secondly, based largely on the data for 1975 and 1976, mercury contained in sediments in Berrys Creek may be more mobile during the winter (December, January) than during the spring or summer.

At times of low water, the direction of flow in Berrys Creek is from north to south, and water flows from the Paterson Plank Road Station to the Route 3 Station. The data in Table 6 suggest that the concentration of mercury in the water was reduced between these two stations on 15, 18, and 24 July and during September, October, and November 1974. This may indicate that the Berrys Creek tidal marsh sediments acted as a getterer and absorbed mercury. It also could reflect a diluting action produced by runoff from the Sports Complex and the effluent from the sewage treatment plant in Rutherford.

Since December 1975, the trend of mercury during periods of low water apparently has changed. In most of the recent analyses, the concentration of mercury at Route 3 has been higher than the concentration at Paterson Plank Road. These data suggest that mercury is added to the water in the segment. Our measurements (see Monthly Reports) indicate that no significant mercury is contained in discharges from the Sports Complex. The source, therefore, appears to be either the tidal marsh sediments or the Rutherford sewage treatment plant.

Table 7. Concentrations of mercury in the waters of Berrys Creek at New Jersey Route 3 (LBC, Figure 3) and Paterson Plank Road (UBC, Figure 2). The State surface water quality standard for mercury is 5.00 ppb. Values are expressed as parts per billion (μg/l).

ug/l

		Low Water		High Water		Lagoon
		Route 3	P. Plank Road	Route 3	P. Plank Road	1
		← Flow		Flow →		
1976	September	0.9	1.6			1.2
	August	0.2	0.1			0.3
	July	0.6	1.6			0.3
	June	2.9	0.9			
	May	0.8	0.6			
	April	2.8	2.1			
	March	4.16	3.41			
	February	1.26	2.06			
	January	21.40	5.90			
1975	December	10.4	7.8			
	November	0.14	0.86			
1974	December	4.6	4.1			
	November	2.5	8.3	0.2*	4.7*	
	October	4.3	6.0	1.3*	4.0*	
	September	2.4*	15.0*	11.0	47.5	
	July 25	6.60*	5.20*	4.80	19.00	
	July 24	1.80*	9.30*	10.00	8.40	
	July 18	5.50	7.90	0.20*	0.65*	
	July 15	1.25	2.15	0.50*	1.15*	
	June 27[a]	14.0				
	May 20[a]	2.3				
	May 17[a]	136.				
	May 13[a]	1.5				

[a] Measurements were made at Receiving Point 1, the former tide gate in the perimeter dike.

* Measurements were made at times of successive high and low after periods. This symbol indicates the stage which occurred earliest.

8. RECENT OBSERVATIONS AT THE CHEMICAL PLANT SITE

The New Jersey Department of Environmental Protection and the United States Environmental Protection Agency have conducted intermittent inspections on or near the site of the former chemical plant at Wood-Ridge at least since May 1974. The results of these inspections are summarized in the following subsections.

8.1 Observations on the Land

May 1974: A pile of mercury oxide wastes (about 3 cubic feet) was observed on the surface of the ground. Several buried deposits also were observed. These accumulations were attributed to improper spill cleanups, improper storage or poor maintenance of stored wastes, overturned or ruptured storage drums, and other faulty procedures.

3 July 1974: The soil near a runoff ditch contained 165 ppm of mercury; soil near a drainage ditch on an adjacent site contained 167 ppm of mercury; soil near the West Riser Ditch tide gate contained 147 ppm of mercury.

Summer 1974: Thirty-three samples (cores and surface collections) were obtained from the site. The cores were taken as deep as 3 feet. Concentrations of mercury ranged from 30 to 142,500 ppm (dry soil). The average concentration was about 20,000 ppm. The highest concentrations were observed in samples from the deepest cores.

January 1975: The concentration of mercury in the soil samples from the site ranged from 15 to 130 ppm.

January 1976: It was reported that a 5,000 gallon tank on the property contains mercury contaminated liquid wastes.

8.2 Observations on the Water

3 July 1974: Concentrations of mercury (ppb) observed at three points were:

Water discharged to drainage ditch	13,000
Ditch leading to Berrys Creek	300
Berrys Creek at tide gate, high water	Not detected

20 September 1974: Concentrations of mercury (ppb) observed at three points were:

Runoff ditch on the site	15,800
West Riser Ditch, upstream	1.1
West Riser Ditch, downstream	940

January 1975: The concentration of mercury in a runoff ditch was 3 ppb.

Summer 1975: The concentration of mercury in a runoff ditch was 3,400 ppb.

September 1976: The concentrations of mercury in the West Riser Ditch at the tide gate were 0.43 and 2.1 ppb. At a point 0.75 mile upstream, the concentration was 0.2 ppb.

8.3 Observations on Sediments

15 September 1976: The concentrations of mercury in sediments in the West Riser Ditch at the tide gate were 4,480 and 577 ppm. At a point 0.75 mile upstream from the site of the former chemical plant, the sediments contained 5.5 ppm mercury.

8.4 Observations on Plants

15 September 1976: Plants were collected from a marsh area on Berrys Creek at Starkey Road in Moonachie, approximately at short core Station 1 (Figure 2). The concentrations of mercury in the "stems" (leaf bases) of cattail and common reed were 1.2 ppm and 3.5 ppm, respectively. In "root tubers" (rhizomes) of the species, the concentrations were 51 and 170 ppm, respectively.

8.5 Observations on Aquatic Animals

The edible parts of a male blue crab that was collected on 15 September 1976 from Berrys Creek near the LBC monitoring site (Figure 3) contained 0.07 ppm mercury. The concentration of mercury in a killifish collected near the West Riser Ditch tide gate on the same date was 0.3 ppm and the concentration in a specimen from the West Riser Ditch 0.75 mile upstream from the site of the former chemical plant was less than 0.03 ppm.

9. MERCURY IN TISSUES OF MUSKRATS FROM BERRYS CREEK MARSH

Samples of the blood and major tissues of four muskrats obtained from the Berrys Creek tidal marsh were analyzed for mercury. The animals were collected on 8 January 1975 and were frozen until the analyses were conducted. The tissues were digested by sulphuric acid and nitric acid.

Muskrats are relatively abundant in the Berrys Creek marsh and they feed on the rhizomes and leaves of common reed grass, cattails, and other plants. They are exposed to mercury on sediments ingested accidentally and to mercury contained in the plant tissues.

The results of the analyses are presented in Table 8. The highest observed mean concentrations of mercury were in the kidney (0.193 ppm) and brain (0.093 ppm). The mean concentrations, and most of the individual measurements, exceeded the expected natural background level of 0.035 ppm. None of the measurements exceeded 0.5 ppm, which is the maximum concentration permitted in commercial meats sold for human consumption.

Table 8. Concentrations of mercury (ppm, wet weight) in blood and tissues of muskrats collected from the Berrys Creek tidal marsh, East Rutherford, Bergen County, New Jersey, on 8 January 1975[a].

Specimen	Blood	Brain	Liver	Kidney	Muscle	Fat
Female 1	.040	.069	.022	.260	.019	.049
Female 2	.040	.130	.040	.200	.050	.050
Female 3	.040	.144	.034	.135	.040	.034
Male 1	.050	.000	.056	.178	.050	.077
Mean	.042	.086	.038	.193	.040	.052

a One milliliter of blood was used in each analysis, and concentrations are expressed in µg/ml. Sample sizes for tissues varied, but concentrations are expressed in µg/g on a wet weight basis.

10. SIGNIFICANCE OF THE TEST RESULTS

Levels of mercury in the waters of Berrys Creek at Route 3 since 13 May 1974 have ranged from 0.2 to 136 ppb, with an average of 9.9 ppb during 23 observations. This average concentration exceeds any average previously published, and the maximum concentration observed in Berrys Creek is equal to the highest concentration reported in the world literature surveyed for this report.

The mean concentration of mercury observed in the waters of Berrys Creek at Route 3 during monthly analyses from January through September 1976 was 3.9 ppb.

Sediments in the West Riser Ditch, at the point of discharge of a discontinued mercury processing plant, were found to contain mercury (total) in concentrations as high as 8,475 ppm. Sediments in the channels of tidal guts in the Berrys Creek tidal marsh, which is approximately 1 mile downstream from the plant site, contained as much as 455 ppm total mercury. The maximum concentration in the West Riser Ditch was nearly 2.5 times as great as the highest concentration previously reported in the available world literature (3,504 ppm in a small swamp at Ashland, Massachusetts).

Concentrations of mercury measured in rhizomes of cattail and common reed in marshland along Berrys Creek near the source of contamination were 51 ppm and 170 ppm, respectively. The highest concentration previously known to have been reported in the world literature is 3.5 ppm in plants rooted in soils over bodies of mercury ore in Alaska. Metallic mercury has been reported to have been observed in the seed pods of one plant, but this has not been verified and no concentration for the organ was listed.

The highest concentration of mercury in the tissues of muskrats collected during winter from the Berrys Creek tidal marsh was 0.260 ppm. In one blue crab and one killifish from the Berrys Creek system, mercury levels were found to be 0.07 ppm and 0.30 ppm, respectively. Although these concentrations exceed the maximum natural background levels for mammals (0.035 ppm) and for fish (0.10 ppm), they are less than the level permissible in foodstuffs (0.5 ppm) and considerably below the concentrations which may result in acute toxicity (12 to 20 ppm).

The available data indicate that the streams and wetlands of the Hackensack Meadowlands District are more severely contaminated with mercury than any other area known in the world. Results of recent tests on large marsh plants suggest that mercury is present at high concentrations in their rhizomes. Analyses of four muskrats, one blue crab, and one killifish revealed slightly elevated levels of mercury, but the concentrations do not pose a danger to humans and are not expected to produce ill effects in the animals. Information on mercury in plants and animals from the Meadowlands District, however, is too limited to permit an absolute assessment of the biological impact of the environmental contamination.

Sediments in long cores extracted from the Berrys Creek tidal marsh are contaminated significantly with mercury (1.0 ppm or more) to depths ranging from 3 to 6.5 feet. Long cores from two locations in the Sawmill Creek Wildlife Management Area exhibit significant contamination to depths of 3.4 and 4.7 feet. These findings suggest that the removal only of the uppermost few inches of sediments would not be an effective solution to the problem of mercury contamination.

11. RECOMMENDATIONS

11.1 Analyses of Sediments

No further collections or analyses of sediments on the behalf of the Authority are recommended. Our analyses of cores of sediments have identified the general geographic variations of mercury concentrations in the central Meadowlands District. Similarly, our analyses of long cores have provided detailed information on the vertical distribution of mercury in the marsh sediments.

11.2 Analyses of Aquatic Plants and Animals

Tests have established that the sediments in the Berrys Creek tidal marsh and in the aquatic environment throughout the central part of the Meadowlands District contain excessive levels of mercury. The most critical question to be answered now is, "does mercury move from the sediments into the aquatic food chain?" The answer will determine the general direction of further planning for the restoration of the Berrys Creek marsh and for any region-wide action that may be required.

The very limited data now available, derived from analyses of two plants, one fish, one crab, and four muskrats, suggest that mercury is entering the food chain, but it is moving through the food chain very slowly. Although very high concentrations were detected in plants, only relatively low concentrations were detected in muskrats, which feed on the plants. The concentrations in the crab and a small fish indicated contamination, but were within the acceptable limits for human foodstuffs.

We previously recommended that a field survey of aquatic organisms be conducted before 31 October to evaluate local populations and to obtain specimens for analysis for mercury. Owing to seasonal changes, if the collections were not completed by this date, the field survey would have been delayed until the next growing season, or about 1 June 1977. In the absence of authorization of the collections from the Authority, the Ventron Corporation, Beverly, Massachusetts, funded the field work. The survey included eight stations in Berrys Creek and the Berrys Creek Canal, the Berrys Creek tidal marsh and its guts, the Hackensack River, and the Sawmill Creek Wildlife Management area. Specimens were selected to represent organisms at different levels in the food chain (algae, plankton, rooted plants, macroinvertebrates, crabs, scavenger fish, predatory fish, small mammals, etc.), the most abundant organisms, and organisms likely to be eaten by human beings.

We now recommend, and request permission to conduct, analyses to determine the concentrations of mercury in approximately 250 plant and animal samples from the Berrys Creek tidal marsh and other locations in the central part of the Meadowlands District. The results of these tests will indicate the degree to which mercury is moving into and through the local food chain. This information is essential for an assessment of any potential adverse effect on wildlife or humans, and will be basic to the formulation of recommendations for the restoration of the Berrys Creek tidal marsh.

11.3 Water Monitoring Program for Mercury

Although additional monitoring for mercury in the waters of Berrys Creek would provide a better record to describe the transport of mercury in the water column, we do not consider this information now to be critical. No intensification of the monthly monitoring, therefore, is recommended at this time.

11.4 Determination of Chemical Forms of Mercury

Mercury occurs in elemental form and in a variety of organic and inorganic compounds. Methylmercury is the most hazardous to living aquatic organisms.

Particularly if the intensive biological survey that we recommend verifies that mercury is not present in especially high concentrations in aquatic animals, it may be important to determine the predominant form(s) of mercury in the sediments. This information would be basic to evaluate the potential mobility of the metal and predict its residence time if a no-action alternative were selected for the restoration of the Berrys Creek tidal marsh.

No recommendation can be made until the analyses of the plant and animal specimens are completed.

12. ALTERNATIVES FOR RESTORATION

Based on the information summarized in this report, three alternative methods for the restoration of the Berrys Creek tidal marsh may be viable. Additional information, particularly in regard to concentrations of mercury in aquatic plants and animals, is needed to evaluate these alternatives and select between them. Any action that is taken to alleviate contamination in the Berrys Creek tidal marsh, of course, should be coordinated with a plan which encompasses the entire affected area within the Meadowlands District.

12.1 Remove and Replace Surface Sediment

Method: Remove the sediments resting above the red-brown peat layer (a thickness ranging from 1 to 1.5 feet). Replace this material with a 0.5 to 1.0 foot thick layer of sand, and plant marsh vegetation on the new surface.

Purpose: The bulk of the mercury in the aquatic environment is present in the surficial sediments. These would be removed and contained or decontaminated. The sand layer would isolate the remaining sediments and minimize any resuspension.

Disadvantages: If other contaminated areas, including the stream channels, were not treated similarly, the new marsh could act as a getterer. In such a case, it eventually would be recontaminated by mercury released from the untreated areas.

The cost of treatment could exceed $35,000 per acre.

12.2 Isolate Contaminated Marsh by Embankment

Method: Erect an embankment along Berrys Creek to isolate the contaminated marsh sediments and cover the enclosed area with impermeable materials. Establish freshwater ponds and upland vegetation on the surface to provide alternative wildlife habitat.

Purpose: Mercury contained in the sediments of the marsh and channels would be enclosed and contained by the embankment. This would prevent reentry of the mercury into the aquatic system of the Hackensack River estuary. By covering the contaminated sediments, the mercury also would be isolated from entering the plants and animals that come to inhabit the site.

Development of freshwater and upland habitats will respond to the requirements of the Hearing Officers' Report, and will compensate for the loss of tidal habitats.

Disadvantages: This method would irreversibly destroy tidal wetland habitat and will alter to some degree the potential for flooding in the region. Particularly if the method were applied to several hundred acres of contaiminated wetlands in the region, the character of the area would be altered drastically and flood levels could be affected significantly.

The cost of treatment has not been calculated, but it probably would exceed $45,000 per acre.

12.3 No Action

Method: Do nothing. Allow the contaminated sediments to remain in place and rely on natural processes to purge the area of mercury. No reliable basis for an estimate of the time required for this purging to be completed has been found, but statements in the literature suggest it would be no less than 100 years.

Purpose: Election of this method would be based on findings that mercury is not entering the aquatic food chain at a significant rate. By doing nothing, of course, the character of the wetlands will be retained; there will be no effect on flood potentials in the region; and there will be no cost for treatment. Should any change in the dynamics of mercury occur in the future, the generation then in a decision-making position will be able to determine the appropriate actions.

Disadvantages: The knowledge that sediments in the area are heavily contaminated with mercury, which potentially is poisonous to wildlife and to man, may have adverse psychological effects on persons who visit or who are considering residence in the Meadowlands District. Unforeseen changes in the aquatic environment potentially could alter the chemical dynamics of mercury in the sediments, and allow the metal to be absorbed rapidly by organisms. If this were to occur, the burden of treatment will be transferred to a future generation. In any case, succeeding generations will inherit a responsibility to monitor the behavior of mercury as a safety precaution.

13. LITERATURE SOURCES

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September 28, 1976

Mr. David C. Longstreet
Office of Special Services
N. J. D. E. P.
P. O. Box 2809
Trenton, N. J. 08625

Dear Dave:

Pursuant to your letter of September 10, 1976, concerning Ventron, let me suggest that you and your legal people meet with EPA staff at 10:00 a.m. on October 28, 1976. The Edison laboratory, of course, is available and in fact preferred by us, since we have a number of people involved in this effort.

Let me know if the date is acceptable.

Sincerely yours,

William J. Librizzi
Director
Surveillance & Analysis Division

Enclosure

cc: M. Polito
H. Gluckstern
J. Birri
F. Brezenski
H. Jeleniewski
J. Lafornara
P. Elliot

S&A:WJLibrizzi:gm:Bldg.10,X401:9/28/76

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CONCURRENCES

SYMBOL								
SURNAME								
DATE								

2nd a 4th ~~third~~ week Oct.

State of New Jersey
DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES
TRENTON, NEW JERSEY 08625

September 10, 1976

Mr. William Librizzi
EPA Region II
Edison, New Jersey

Re: State vs Ventron et al
Docket No. C-2996-75

Dear Bill:

As you know, the State has filed suit in the referenced matter as a result of mercury pollution of the waters of the State. We are now in the discovery procedure.

In order to document our case more fully our Deputy Attorney General Mr. Ronald Heksch would like to interview the members of the EPA staff, including laboratory personnel who were involved in any phase of this case, sometime during October.

We therefore request that you establish a date convient to you. It is suggested that Friday's be avoided. Friday's are motion days in New Jersey Courts.

Please let me know dates that are acceptable to you as soon as possible.

Thank you for all of the cooperation EPA has given the State in this very complex problem.

Sincerely yours:

David C. Longstreet

David C. Longstreet
Supervisor, Spill Prevention
Office of Special Services

c.c.: Mr. Henry Gluckstern
R. Heksch

E23:G6

Polito
Librizzi
Gluckstern
Berry
Jelinski
Laforanna

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Director, S&A Division

meeting EPA 10/28/76

Ronald [illegible] NJ DEP
Mike Polito EPA.
Henry Zelenieuski EPA
John Birri "
Don Kampbell "
Karl F. Birns NJDEP
Ronald P. Hersch N.J. Atty General's Office
Henry Gluckstern EPA N.Y. 2122644430
Stuart Meislik N.J. Atty General's Office
Joseph P. Lafornara EPA, ORD, Oil & Hazardous Spills
Dick Dowling

Persons involved at a meeting to discuss Ventron in general.

MEMORANDUM

(27)

STATE OF NEW JERSEY
DEPARTMENT OF ENVIRONMENTAL PROTECTION

TO: File

FROM: David Longstreet DL

SUBJECT: State v. Wolf et al

DATE: November 3, 1976

At the request of Deputy Attorney General Ron Heksch, Mr. William Althoff and the writer took soil samples in Wood-Ridge/Carlstadt in Bergen County on September 29, 1976. The samples were taken in an area designated as belonging to Velescol Chemical Company.

The location of the sampling points as well as the results are plotted on an aerial photo taken for the Hackensack Meadowlands Development Commission.

A base line was established by sighting along the edge of a green house and moving in a southerly direction. Samples "0" through "4" were taken along this base line. A second line was established at right angles to the first. Samples "5" and "6" were taken along this line. Sampling point "0" was established by measuring 85 feet south from the fence bordering the railroad line and 63 feet east of corner of new building. All subsequent measurements were taken from these two lines.

The samples were delivered to the Health Departments Laboratory on October 4, 1976 for analysis.

The following table lists the samples and results:

PPB Hg

Sample Point	Results	Remarks
01	3300	Initial point
1A1	5000	280 feet south of 01
2A1	3200	500 feet south of 01
3A1	3200	700 feet south of 01
4A1	5000	843 feet south of 01
5A1	3000	300 feet east of 01
6A1	3260	555 feet east of 01
8A1	3500	200 feet south of 5A1
9A1	3500	300 feet south of 5A1
10A1	4200	400 feet south of 5A1
11A1	3200	500 feet south of 5A1
12A1	13600	700 feet south of 5A1

13A1	4200	637 feet south of 5A1 and 300 feet east at right angle to line 5A - 12A
14A1	4200	137 feet north of 13A1
15A1	3800	337 feet north of 13A1
X1	3300	Sample taken from piled material located on line 5A - 12A on road between 5A and 8A
Y1	6600	Taken from piled material 806 feet from 01 on line 01 - 5A
Z1	3300	Taken from piled material near 4A

It should be noted that 7A was not used as a sample identification number.

The laboratory sheets are in the file.

c.c.: Ron Heksch
W. Althoff

E23:G6

Jim - by 11/20/76

From: Log 11/10/76

Please supply me with comments and the files / I'll write final letter OK thanks

D

State of New Jersey

DEPARTMENT OF LAW AND PUBLIC SAFETY

DIVISION OF LAW

ENVIRONMENTAL PROTECTION SECTION

36 WEST STATE STREET

TRENTON 08625

WILLIAM F. HYLAND
ATTORNEY GENERAL

ROBERT J. DEL TUFO
FIRST ASSISTANT ATTORNEY GENERAL

STEPHEN SKILLMAN
ASSISTANT ATTORNEY GENERAL
DIRECTOR

MORTON GOLDFEIN
DEPUTY ATTORNEY GENERAL
CHIEF

November 8, 1976

Dr. Richard Dewling
U.S. Environmental Protection Agency
Region II
Edison, New Jersey 08817

Re: State of New Jersey v. Ventron/Wolf Realty

Dear Dr. Dewling:

I am writing to confirm my request at a meeting we had last Thursday, October 28, 1976, that EPA personnel provide the State of New Jersey with assistance in litigating the above captioned matter.

As I indicated to you, this case involves mercury pollution in the Hackensack Meadowlands, more particularly a 17 acre parcel in the Borough of Wood-Ridge adjacent to Berry's Creek and Berry's Creek itself. The site in question was used for years as a mercury processing plant and is believed to be a major source of mercury pollution in the area. In particular during the summer of 1974 certain buildings on the premises were demolished and this demolition resulted in runoff into Berry's Creek, which caused the mercury content of that body of water to increase appreciably.

Both EPA and the New Jersey Department of Environmental Protection are familiar with the aforementioned problem and have conducted both joint and independant investigations of the site and surrounding area. Our office got involved after negotiations were entered into with the present owner of the property, Robert and Rita Wolf, to see if a volun-

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Director, S&A Division

tary abatement procedure could be arrived at. These negotiations were unsuccessful because of the property owner's unwillingness to be responsible for long term abatement procedures proposed and as a result, the above lawsuit was instituted.

It is expected that this case will be tried sometime in 1977. We are presently in the discovery stage of the litigation and I must provide the other parties involved with any and all information I have concerning this matter. Because of this, I need to know the full extent of EPA's involvement. Furthermore, when this case is tried, I may need EPA personnel to testify with regard to on site inspections, samples taken, and laboratory analysis of these samples.

By reason of the aforementioned, I would be most appreciative if you would forward to me a complete copy of your file along with a chronological outline of EPA's involvement. I would also appreciate your authorizing EPA personnel involved in this matter to be available to testify if and when the need arises.

Your agency's cooperation will be greatly appreciated. If you require any additional information from me, please advise.

Very truly yours,

WILLIAM F. HYLAND
ATTORNEY GENERAL

BY: Ronald P. Heksch
Ronald P. Heksch
Deputy Attorney General

RPH:cim

cc: Karl Birns
David Longstreet
Henry Gluckstern

DAG HEKSCH, 36 W. State St.

STATE OF NEW JERSEY
DIVISION OF LAW
DEPARTMENT OF LAW AND PUBLIC SAFETY
BOX 1869
TRENTON 08625

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Dr. Richard Dewling
U.S. Environmental Protection Agency
Region II
Edison, New Jersey 08817

Nov. 16, 1976

"Monitoring the Uptake of Mercury in Berry's Creek"

A Cooperative Project - Interim Report

Cooperators:

New Jersey Division of Fish, Game & Shellfisheries, Bureau of Fisheries
United States Department of Environmental Protection, Region I

Drainage: Hackensack River
Stream: Berry's Creek
N.J. Surface Water Quality Classification: TW-2
Suspect Source: Ventron Corporation
(a.k.a. - Wood Ridge Chemical Company)
(a.k.a. - Rovic Construction Company)
(a.k.a. - Wolf Realty)
Location: Park Place East (Lot 10, Block 229)
Wood Ridge Borough, Bergen County, New Jersey
Suspect Pollutant: Mercury
Dates of Investigation: August 25, 1975
August 25, 1976
Principal Investigator: D. J. Jacangelo, Sr. Fisheries Biol.

The data herein presented represents a summary of two years of a proposed three year mercury monitoring program. This monitoring project is being conducted by the Division of Fish, Game and Shellfisheries in cooperation with the U. S. DEP - Region II Office in Edison. This Project provides that the Division collects and delivers samples and prepares reports, while the E.P.A. office in Edison conducts the analytical analysis.

The identification of field sample stations monitored in the course of this project follow:

Station No.	Station Identification
1	Control - Berry's Creek at Pumping Station in Teterboro (approx. 1.2 mi. above #2)
2	Berry's Creek at West Tide Gate, off Grand Street in Carlstadt
3	Berry's Creek at Starkey Drive (approx. 0.2 mi. below #2)

1975

N.J. Station No.	EPA Lab No.	Sample	mg/kg. Hg(dry wt.)	ug/l. Hg.
1	40264	Sediment	0.3	
1	40257	Water		0.3
2	40262	Sediment	25	
2	40255	Water		0.6
3	40263	Sediment	35	
3	40256	Water		0.4

1976

N.J. Station No.	EPA Lab No.	Sample	mg/kg. Hg(dry wt.)	ug/l. Hg.
1	37083	Sediment	5.5	
1	37084	Water		0.20
2	37079	Sediment	577	
2	37080	~~Water~~ Sediment	4,480	2.1
3	37082-	Water		0.43
3				

1975

N.J. Station No.	EPA Lab No.	Sample	mg/kg. Hg(wet wt.)	mg/kg Hg.
2	40258	Cattail(tuber & top)	0.3	
2	40265	Cattail(stem)	1.2	
3	40259	Phragmites(tuber & top)	1.5	
3	40266	Phragmites(stem)	1.1	
	40260	Killifish(whole fish)		0.4

1976

N.J. Station No.	EPA Lab No.	Sample	mg/kg. Hg(dry wt.)	mg/kg. Hg.
1	35875	Phragmites(tuber)		4.2
1	35825	Phragmites (stalk)		4.2
1	37150	Killifish(whole fish)		<0.03
3	37085	Cattail(root tuber)	51	
3	37085	Cattail(stem)	1.2	
3	37086	Phragmites(root tuber)	170	
3	37086	Phragmites(stem)	3.5	
	35824	Killifish(whole fish)		0.3
	*37273	Blue crab (female)		L.A.
	37272	Blue crab (male)		0.07

*L.A. = Lab accident

D. J. Jacangelo
Sr. Fisheries Biol.

saw
cc Chief A. Bruce Pyle, Fisheries
cc Michael V. Polito, Emerg. Response & Insp. Br., EPA, Region II
cc Dr. Peter W. Preuss, Special Ass't. to Commissioner, N.J. DEP
cc Karl F. Burns, Oil & Hazardous Mat. Spill Sect., N.J. DEP
cc Dave Longstreet, " " " " "

Jack McCormick, Ph.D.
President
Jack McCormick and Associates
511 Old Lancaster Road
Berwyn, Pennsylvania 19312

Dear Doctor McCormick:

We have received your correspondence of November [illegible] 1976 and the enclosed report concerning mercury contamination in the sediments and waters of the Hackensack Meadowlands District.

Our agency has been involved with this problem for a few years now. This is another example of the type of long-term damage that is incurred upon our environment when we fail to implement proper environmental controls. We agree with you that the next step in your investigation should be studies concerning the incorporation of mercury into the Meadowlands' food chain. We trust that you will send us a copy of your report upon completion of this study. At that time we will be glad to provide our support and recommendations.

Thank you for coordinating with us in this matter.

Sincerely yours,

Conrad Simon
Director
Environmental Programs Division

2EP:WB.HUDEK:rm:X9266:11/23/76

JACK McCORMICK & ASSOCIATES, INC.
A subsidiary of WAPORA, Inc.

511 OLD LANCASTER ROAD
BERWYN, PENNSYLVANIA 19312
(215) 647-9000

6 December 1976

Mr. Lawrence Schmidt
Office of Environmental Review
New Jersey Department of Environmental
Protection
P. O. Box 1390
Trenton, New Jersey 08625

Dear Mr. Schmidt:

Enclosed please find a revised list of organisms and map of station locations concerning the October biological survey in the Hackensack Meadowlands by JMA biologists. The map transmitted to you on 23 November 1976 incorrectly identified the locations of Sawmill Creek, Station 6, and Station 8. Station X represents a trapping site where no additional biological collections were made. The revised table listing organisms collected provides summary information not included on the original table.

Please contact me if you have any questions concerning the revised material.

Very truly yours,

Frank A. Camp

Frank A. Camp, Ph.D.
Vice President

/nad

cc: J. McCormick

Enclosures

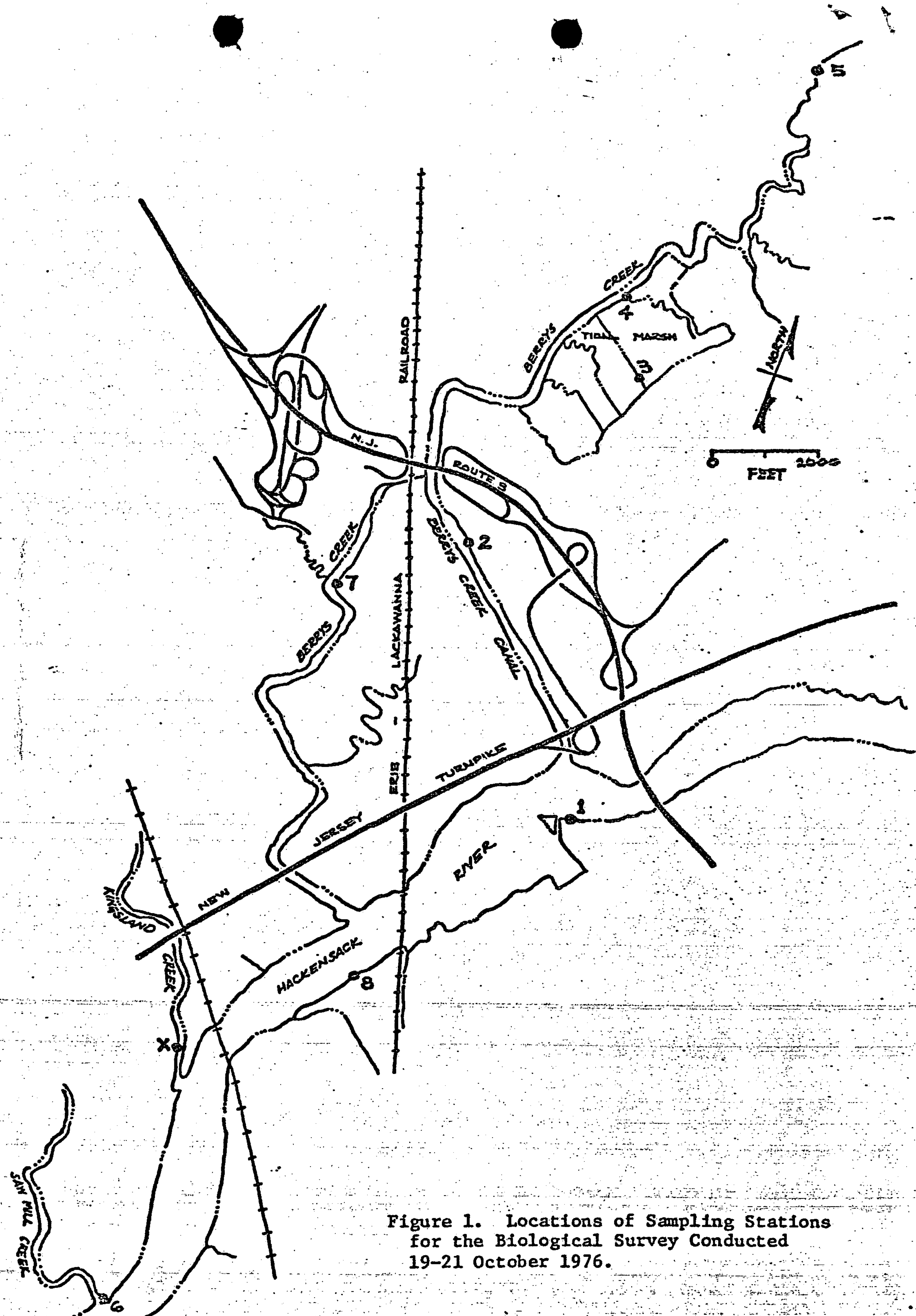

Figure 1. Locations of Sampling Stations for the Biological Survey Conducted 19-21 October 1976.

Table 3. Inventory of organisms collected from the Hackensack Meadowlands, 19-21 October 1976.

Scientific Classification	Common Name	1	2	3	4	5	6	7	8
		STATIONS							
Plants									
Phragmites communis	Common Reed Grass	X	X	X	X	X	X	X	X
Spartina alterniflora	Low Water Cordgrass					X			
Typha	Cattail				X				
	Blue Green Algae	X							
	Unidentified Grass					X			
	Plankton	X	X	X	X	X	X	X	X
Macroinvertebrates									
Phylum Rhynchocoela (unidentified non-segmented worm)		1							
Phylum Mollusca									
Class Gastropoda									
Subclass Pulmonata									
Order Basommatophora									
Family Ellobiidae									
Melampus bidentatus	Marsh snail	1			1				
Class Bivalvia									
Subclass Teleodesmata									
Order Heterodontida									
Family Dreissenidae									
Congeria leucopheata	False mussel	25		3					

Table 3. Inventory of organisms collected from the Hackensack Meadowlands (continued).

Scientific Classification	Common Name	1	2	3	4	5	6	7	8
		STATIONS							
Phylum Arthropoda									
Class Insecta									
Order Diptera									
Unidentified early instar larvae		14							
Class Crustacea									
Subclass Cirripedia									
Order Thoracica									
Suborder Balanomorpha	Acorn Barnacles								
Family Balanidae									
Balanus improvisus		103+	11	55	100+	17			
Subclass Malacostraca									
Order Isopoda	Sow Bugs								
Suborder Anthuridea									
Family Anthuridae									
Cyathura polita		1					1		
Suborder Onoscoidea									
Family Onoscoidae									
Philoscia vittata					3				
Order Amphipoda	Scud								
Suborder Gammoridea									
Family Talibridae									
Orchestia grillus			15		7		1		

Table 3. Inventory of organisms collected from the Hackensack Meadowlands (concluded).

Scientific Classification	Common Name	STATIONS 1	2	3	4	5	6	7	8
Order Cypriniformes									
Family Cyprinidae	Minnow and Carps								
Carassius auratus	Goldfish							1	
Order Atheriniformes									
Family Cyprinodontidae	Killifish								
Fundulus spp.		7	15	18	3	51	4	5	8
Order Perciformes									
Family Sciaenidae	Drums								
Leiostomus xanthurus	Spot	1					1		7
Rodent *Mus musculus*	House mouse					1			
Number of Species Collected		14	7	5	9	7	10	7	9
Approximate Number of Individuals Preserved		241	70	82	129	81	32	25	156

Note - All plant samples were collected at least in triplicate.

\+ - Indicates at least this number was preserved.

Table 3. Inventory of organisms collected from the Hackensack Meadowlands (continued).

	Scientific Classification	Common Name	STATIONS 1	2	3	4	5	6	7	8
	Order Decapoda									
	Infraorder Caridea	Caridean Shrimp								
	Family Palaemonidae									
	Palaemonetes pugio		65	10		6		11		129
	Family Crangonidae									
	Cragon septemspinosa							2	7	1
	Infraorder Brachyura	True Crabs								
	Section Brachyrhyncha									
	Family Portunidae									
	Callinectes sapidus	Blue Crab								3
	Family Xanthidae									
	Phithropanopeus harrisii	Mud Crab	13	13				1	5	
	Family Ocypodidae									
	Uca pugnax	Fiddler Crab						5		1
Fish	Class Osteichlhyes	Bony Fishes								
	Order Anguilliformes									
	Family Anguillidae	Freshwater Eels								
	Anguilla rostrata	American Eel	1						1	
	Order Clupeiformes									
	Family Clupeidae	Herrings								
	Alosa pseudoharengus	Alewife								1

December 8, 1976

Mr. Ronald P. Heksch
Deputy Attorney General
New Jersey State Department of
Law and Public Saftey
Environmental Section
36 West State Street
Trenton, New Jersey 08625

Dear Mr. Heksch:

As requested, attached is a chronological listing of EPA's involvement with Ventron. Mr. David Longstreet, NJDEP, has the supportive information for the chrono - see letter dated November 10, 1976 from M. Polito. Do you also need this back-up, or can you obtain it from Dave?

Ron, the EPA, Edison, N.J. staff stands ready to assist you in either case preparation or testimony. My only request is that you provide us with at least 10 days notice.

Look forward to hearing from you.

Sincerely yours,

Richard T. Dewling
Director
Surveillance & Analysis Division

cc: H. Gluckstern
F. Brezenski
M. Polito
K. Birns

S&A:RTDewling:rfw:Bldg. 10, ext. 6754:12/8/76

Ventron